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IN VIVO HIGH RESOLUTION MRI (7T) OF AGE- AND OSTEOARTHRITIS RELATED VARIATIONS OF FEMOROTIBIAL CARTILAGE IN THE RAT KNEE: A PILOT CROSS SECTIONAL STUDY WITH HISTOLOGICAL CORRELATION

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Purpose: To assess age- and osteoarthritis (OA)-related changes of femorotibial cartilage thickness and volume in rat knees by 3D MRI (7T).
Methods: MRI were performed *in vivo* at 7 T on healthy and OA knee joints. Gradient Echo Fast Imaging 3D MR images were acquired in 4 classes of age in young, juvenile, adult and mature healthy male rats and then sequentially in surgically-induced OA in Wistar rats. Medial and lateral femorotibial joint space width (JSW), lateral and medial femoral and tibial cartilage thickness, and finally femoral and tibial (medial and lateral) volumes were quantified from MRI. At each time-point, animals were sacrificed for concomitant histomorphometry.
Results: In healthy rats, as body weight dramatically increased (+141%, baseline vs endpoint), both medial & lateral JSW decreased by 40%. As femoral cartilage volume decreased (-33%), chondral reduction was minimal in both medial (-18%) and lateral (-12%) tibial compartments. After normalizing cartilage tibial volumes to subchondral bony area, a significant decrease was present. In OA rats only a significant increase of medial tibial thickness and normalized volume were present, concomitantly to focal femoral erosions versus age-matched contralateral normal knees D28 after OA induction.
Conclusions: Cartilage measurement based on 3D MR images enables *in vivo* monitoring of both age-and OA-related changes of femorotibial rat cartilage thickness and normalized volume. Correlations between MR and histomorphometry were limited by partial volume effect, topographical concordance and histological processing, especially in OA cartilage.

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ARTICULAR CARTILAGE LESION ASSOCIATED WITH ACUTE ANTERIOR CRUCIATE LIGAMENT INJURY OF THE KNEE: A STUDY WITH T2 MAPPING

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Purpose: Anterior cruciate ligament (ACL) injury has been associated with early occurrence of osteoarthritis (OA), which was originally believed to be due to instability derived from ACL insufficiency. However, recent studies showed more than half of the patients who had ACL reconstruction will develop OA changes within 10 years after an ACL rupture. These findings suggest that the initial injury to the articular cartilage and subchondral bone may also play a role in the development of OA. On the other hand, the relationship between acute ACL injury and cartilage lesion has not been well documented.
Transverse relaxation time (T2) mapping is a magnetic resonance (MR) imaging technique that has the potential to quantitatively evaluate deterioration of molecular composition and structural integrity of articular cartilage. The aim of this study is to evaluate the relationship between acute ACL injury and cartilage lesion by using T2 mapping. We especially focused on the relationship between the presence or absence of bone bruise and cartilage injury overlying bone bruise.
Methods: Seventy three knees of 73 patients (32 women and 41 men, mean age 28.2±7.6 years) with acute ACL injury were studied with an MR imaging system at 1.5 Tesla (Signa, GE Medical Systems, Milwaukee, WI). Fat-suppressed T2 weighted imaging and T2 mapping in the coronal plane were performed, and T2 value of the cartilage at medial and lateral condyle was measured. For the comparison of T2 value, 40 knees of 20 healthy volunteers (16 males, 4 females, mean age 34.9±6.2 years) without symptoms of knee pain or previous medical treatment concerning knee trauma underwent T2 mapping as the same manner. A multi-spin-echo (MSE) sequence was used for T2 measurement, and scanning parameters were 1500 msec TR, 8 TEs of 12.4-99.2 msec, 140×140 mm field of view, 3.0-mm slice thickness, 384×384 matrix, and 1 excitation. To evaluate the relationship between acute ACL rupture with and without bone bruise and cartilage injury, T2 value of cartilage at medial and lateral condyle and mean value of entire cartilage at femoral condyle of healthy volunteer were measured. Then each T2 value of cartilage at medial and lateral condyle of the patients without bone bruise and affected and unaffected condyle of the patients with bone bruise were compared. Unpaired and paired T-test was used for statistical evaluation, and statistical significance was defined as $p<0.05$.
Results: T2 values of cartilage at medial and lateral condyle within healthy volunteer were 31.1 ms and 32.3 ms, mean 31.6, and there was no significant difference between them. Of the 73 patients, 34 had a bone bruise at lateral femoral condyle. In the patients without bone bruise, there was no significant difference in the mean T2 between lateral femoral condyle and medial femoral condyle, 32.1 ms and 31.6 ms, respectively. In the patients with bone bruise, the mean T2 of lateral femoral condyle was significantly higher than that of medial femoral condyle, 38.2 and 32.4 ms, respectively.
Conclusions: In this study, a significant increase in the T2 of cartilage at the femoral condyle with bone bruise was observed. On the other hand, no significant increase in the T2 of cartilage at the femoral condyle without bone bruise was observed. It is known that T2 value increases with the loss of collagen anisotropy and increase in water content observed in the damaged or deteriorated cartilage. Thus the presence of bone bruise at the femoral condyle after acute ACL rupture was thought to indicate the presence of cartilage deterioration at that site. Deterioration of articular cartilage associated with bone bruise should be taken into account in clinical treatment for acute knee injury.

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IN VITRO ASSESSMENT OF THREE-DIMENSIONAL TISSUE ENGINEERED ARTICULAR CARTILAGE WITH A COMBINATION OF QUANTITATIVE MR IMAGING TECHNIQUES

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Purpose: In recent years, three-dimensional (3D) tissue engineered cartilage has been used for clinical treatment of full thickness cartilage defect. However, as there was no non-invasive evaluation method of tissue engineered cartilage, detailed characteristics of the “each” tissue engineered cartilage, such as extracellular matrix composition, could not be assessed.
Recently, several qualitative magnetic resonance (MR) imaging techniques have been developed to monitor the cartilage matrix status. Delayed gadolinium-enhanced MR imaging of cartilage (dGEMRIC) is sensitive to the concentration of glycosaminoglycan